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ABSTRACT

The French and Guilford-Zimmerman measures of spatial orientation and spatial visualization factors are compared. Both approaches to measurement are described. A study to assess the two approaches is reported. Both tests were administered to 40 college sophomores in a classroom setting according to published instructions. Pearson product-moment correlations were computed for the multitrait-multimethod matrix. Results indicate that both tests exhibit convergent validity. The data on discriminant validation, however, indicates that variance attributable to methods exceeds variance attributable to traits. The conclusion is that variance due to authorship is greater than that due to trait and that the traits may not be distinct variables. (DJ)

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CONVERGENT AND DISCRIMINANT VALIDATION OF THE FRENCH AND GUILFORD-ZIMMERMAN SPATIAL ORIENTATION AND SPATIAL VISUALIZATION FACTORS

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Although researchers generally agree that a spatial ability factor exists, there has been controversy concerning the nature of the construct and its sub-factors. The existence of several spatial factors and instruments for their measurement have been posited by French (1951), French, Ekstrom, and Price (1962), and Guilford and Zimmerman (1956).

After reviewing several factorial studies, French (1951) described two spatial factors: spatial orientation and spatial visualization. French defined spatial orientation as the aptitude to remain unconfused by the changing orientations in which a spatial configuration may be presented and spatial visualization as the aptitude to comprehend imaginary movement in three-dimensional space.

French, *et al.* (1962) selected two tests for the measurement of these constructs. The spatial orientation test requires the comparison of two cubical blocks. The respondent is asked to indicate whether the two blocks are the same or different according to symbols written on their faces.

The French visualization test requires an examinee to imagine the folding and unfolding of a piece of paper which, when folded, has been

perforated (simulated by circles drawn on the paper) one or more times. Out of five alternatives an examinee must choose the alternative which represents the paper after it has been unfolded and the perforations have been made.

Guilford and Zimmerman (1956) postulated two aptitudes which they also called spatial orientation and spatial visualization. Two tests of the Guilford-Zimmerman Aptitude Survey were designed to measure these constructs. The authors referred to spatial orientation as an ability to appreciate spatial relations with reference to the body of the observer. The awareness of whether one object is to the right or left, higher or lower, or nearer or farther than another is the essential nature of their factor.

The Guilford-Zimmerman test for spatial orientation requires an examinee to imagine that he is riding in a boat whose prow is always visible in the foreground of the pictures comprising each item. In the first picture one sees the prow of a boat and some portion of the seascape in front of the boat. In the second picture the boat has changed its position. The examinee is asked to compare pictures to determine the boat's new heading prior to marking one of five alternatives.

Guilford and Zimmerman described spatial visualization as a process of imagining movements, transformations, or other changes in visual objects. The Guilford-Zimmerman test for spatial visualization consists of a picture of an alarm clock and a sphere with directional arrows. The respondent is asked to visualize the rotation of the clock as it is moved into different positions according to the directions of the arrows. One out of every five choices pictures the clock in its final position.

French, *et al.* (1962) and Guilford and Zimmerman (1956) posited two sets of traits which are generally equivalent to each other. These traits and the meanings ascribed to them by their authors are:

French, et al.

Spatial orientation (SO)	definition: remaining unconfused by changing orientation.
	task: determine the similarity or difference in cubical blocks from symbols on their faces.
Spatial visualization (SV)	definition: comprehending imaginary movement in three-dimensional space.
	task: follow movement of paper with holes from folded to unfolded position.

Guilford-Zimmerman

Spatial orientation (SO)	definition: awareness that one object is higher or lower, left or right, nearer or farther than another.
	task: determining a boat's position from changing seascape.
Spatial visualization (SV)	definition: the process of imagining movements, transformations, or other changes in visual objects.
	task: follow movement of an alarm clock from directional arrows.

The multitrait-multimethod matrix (Campbell and Fiske, 1959) is a technique for examining convergent and discriminant validity, prerequisite to the utility of traits and the tests used to measure them. Convergent validity is a confirmation of traits by independent measurement methods that requires a significant correlation between two different methods measuring the same trait. Discriminant validity requires that the correlation between different methods measuring the same trait exceed (a) the correlations obtained between that trait and any other

trait not having method in common and (b) the correlations between different traits which happen to employ the same method. Variance among test scores can be due to method and/or trait factors. The multitrait-multimethod matrix presents all the intercorrelations which result when selected traits are measured by two or more methods.

Purpose and procedure. The purpose of the present study was to assess the convergent and discriminant validity of the tests for SO and SV selected by French, *et al.* (1962) and constructed by Guilford and Zimmerman (1956). Forty randomly selected college sophomores who had no previous knowledge of the SO and SV instruments were subjects for the study. The Guilford-Zimmerman tests and Form 1 of the French tests were administered in a classroom setting according to the published instructions. Pearson product-moment correlations were computed for the multitrait-multimethod matrix appearing in Table 1.

Table 1. Multitriat-Multimethod Matrix for French and Guilford-Zimmerman SO and SV tests[1]

		Guilford-Zimmerman		French	
		SO	SV	SO	SV
Guilford-Zimmerman	SO	(.88)[2]			
	SV	.67	(.93)[3]		
French	SO	.48	.53	(.66)[4]	
	SV	.34	.44	.55	(.51)[4]

[1] $p < .05$ for all correlations.
[2] alternate forms reliability reported by Guilford and Zimmerman (1956).
[3] Kuder-Richardson 21 reliability reported by Guilford and Zimmerman (1956).
[4] alternate forms reliability determined by the authors.

Results and conclusions. Values in the diagonal represent the convergent validity data. Significant correlations between the French and Guilford-Zimmerman methods of measuring SO and SV indicate that both tests exhibit convergent validity.

The remaining correlations comprise data for discriminant validation. Three validity coefficients outside of the diagonal including both correlations between traits and within method exceed values within the diagonal. The between-traits and within-method correlations indicate that variance attributable to the methods exceeds variance which is attributable to the traits.

Although the validity diagonal demonstrates convergent validity, there is little evidence of discriminant validity. Since correlations of Guilford-Zimmerman SV with SO and French SV with SO exceed the validity diagonal values, the authorship of the tests comprises a larger contribution to the correlations than do the hypothesized traits.

There is other evidence to indicate that both method and trait may be in common to SO and SV. For example, Roff (1952) obtained a correlation of .75 between SO and SV, a value close to the reliabilities of the SO and SV tests cited by Michael, Guilford, Fruchter and Zimmerman (1957).

Smith (1964) argued that in general authorities have yet to demonstrate distinctions between the two hypothesized factors. Smith concluded that a test which requires attention to the details of a configuration probably measures *g*, Spearman's general intellectual factor, more than spatial ability. If Smith is correct, the Guilford-Zimmerman SV test might fall short of this criterion for a true spatial test. It is possible to complete the items of that test by fixating

on some of the details of the alarm clock, e.g., the stand on which it rests or the buttons on its back, as one imagines the movement of the clock. The test might thus be a measure of *g* or some sub-factor of *g*. The same observations apply to the French SO test, since fixating on one of the symbols of a block would appear to facilitate success on the test.

There is evidence that when both SO and SV are measured with either the French or Guilford-Zimmerman tests that the variance due to authorship is greater than that due to trait. From related research Smith contended that SO and SV may not be distinct traits and suggested an additional rationale for between-trait and within-method correlations exceeding the validity diagonal values.

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